RED-BLUE CONNECTOR

Update to 2010 DEIR: Constructability

October 15, 2018

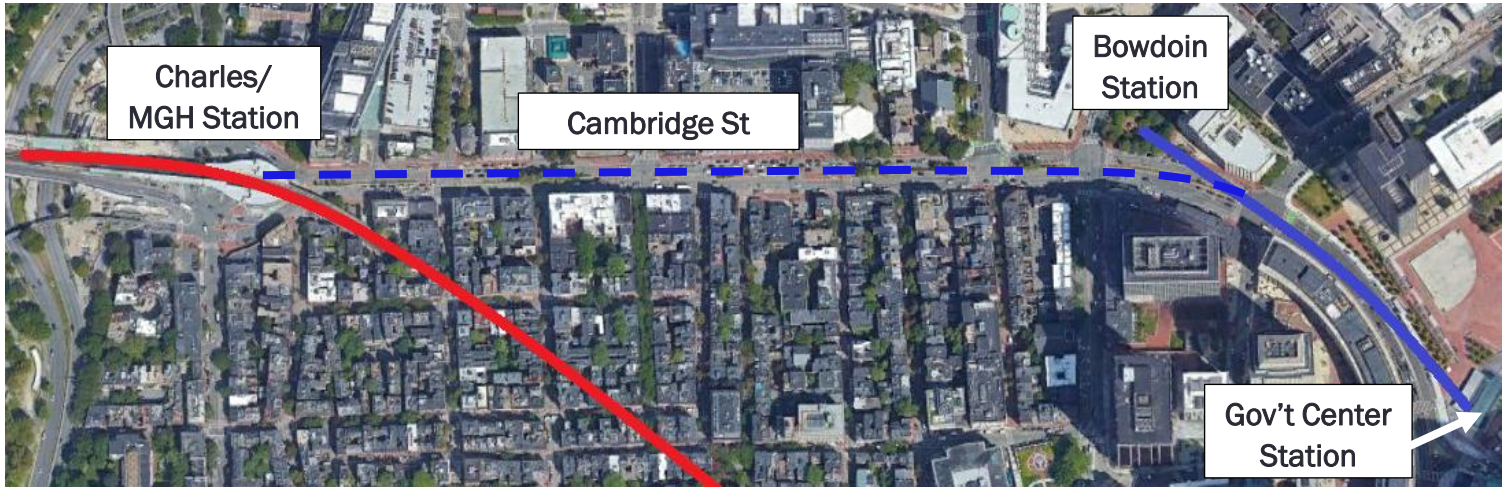
massDOT Massachusetts Department of Transportation

Purpose and Key Issues

- **Presentation Purpose:** Provide the FMCB with a summary of the updated constructability findings from the Red-Blue Connector reassessment.
  - Updated analysis focuses on (1) updating the order of magnitude cost estimate for the Tunnel Boring Machine approach based on technological and industry advancements and (2) reviewing alternative tunnel construction methods to the TBM method presented in the DEIR generating order of magnitude cost estimates for these methods of construction.
  - Analysis will inform decision on whether to include the Red-Blue Connector in the Focus40 “Next Priorities” and subsequent capital planning process

Project Overview

Project extends Blue Line under Cambridge Street and results in a below street-level Blue Line stop at Charles MGH, directly connected to the existing above street-level Red Line stop.



Construction Considerations Outside Scope of DEIR Update

- The analysis focused on the constructability of the tunnel and **does not consider or provide costs estimates for the constructability of the full project,** which includes the following issues:
  - Traffic management and pedestrian disruption during construction
  - Building redundant elevator service to ensure sufficient capacity for vertical movements in the station
  - Moving out the Charles/MGH Station glass façade to accommodate access to the Blue Line Platform below grade
  - Updating designs for emergency egress to meet current code* and the construction approach and maintenance to adhere to current policy

* Emergency egress and pedestrian flows may have been evaluated differently in 2010. The 2010 DEIR was based on Standard for Fixed Guideway Transit and Passenger Rail Systems published by the National Fire Protection Association.

MBTA Construction Priorities

MBTA Chief Engineer and Operations staff identified the following issues that would need to be considered as part of advancing this project:

- Provide equivalent vehicle storage at Charles MGH as currently available at Bowdoin
- Consider future Blue Line headway needs
- Need additional crossover east of Government Center to preserve station functionality during construction
- Consider additional Blue Line headhouse at Grove Street
- Do not assume direct fixation for tracks; keep options open
- Project should be part of plan to replace trip stop signals and eliminate overhead catenary system

ANALYSIS OF TUNNELING METHODS

- Tunneling Construction Challenges
- Cut and Cover (C&C) Top-Down
- Sequential Excavation Method (SEM)
- Tunnel Boring Machine (TBM)
- Cost estimate assumptions and comparison

Tunnel Construction Challenges

- Tunneling in a dense urban area is a complex process due to surface disruptions, the potential for groundwater leakage, and risks associated with disrupting buildings.
- **Challenges specific to the Red-Blue Connector include:**
  - The high groundwater level in this area
  - Sensitivity with the timber piles supporting the Charles/MGH station and other surrounding buildings in the Cambridge Street corridor
  - Existing utilities and the close proximity to Massachusetts General Hospital and other buildings in the area

Cut and Cover (C&C) Top-Down Method

- **Cut and Cover (C&C) Top-Down* excavation:** A trench is excavated from the street-level and covered.
- Pros of Top-Down construction method:
  - Earlier restoration of roadway and sidewalk surface
  - Decreased costs from reduction of temporary works
  - Shorter construction schedule
- Cons of Top-Down construction method:
  - Increased risk for water leakage
  - More complicated connections for roof and wall slabs
  - Limited space for excavation/work under roof slab
  - General contractors are less experienced with Top-Down (preferred method) than Bottom-Up C&C construction
  - These disadvantages can be mitigated during construction

* Bottom-Up construction was not considered because it causes a longer period of surface disruption and requires installation of a temporary support of excavation (SOE) system).

Sequential Excavation Method (SEM)

- **Sequential Excavation Method (SEM):** The main excavation is divided into multiple sections and excavated sequentially to minimize the unsupported ground, thereby enhancing the stability of the ground.
- Pros:
  - Minimal amount of surface disruption (less than C&C and TBM)
  - Can adapt to fit the ground conditions
- Cons:
  - Need for experienced workers
  - Risk for ground surface settlement and groundwater leakage
  - Need for ground improvement

Tunnel Boring Machine (TBM)

- Tunnel Boring Machine (TBM) carves the tunnel out of the ground, removing the soil and conveying it out of the tunnel.
- Pros:
  - Once assembled, excavation goes very quickly
  - Less surface disruption compared to C&C (this advantage is not as pronounced in this project)
  - More experience and competition among contractors
  - Less settlement and risk compared to SEM
- Cons:
  - Large vertical shafts are a major disruption, also require utility relocation at their location
  - TBM must be delivered and assembled (lengthy process)
  - Can only excavate one tunnel at a time
  - Due to high costs of procurement and long assembly time, TBM is less economical for runs less than 1 mile

Cost Estimate Assumptions

- Evaluation of high-level assumptions and relative costs
- Cost estimate includes heavy civil tasks (excavation, station, tail tunnels, shafts, utility relocation) for tunneling
- Cost estimate excludes station and tunnel fit-outs, finishes, system improvements, trainset costs, design costs, testing, and project closeout
  - These activities increase the total cost by 30 to 40%
- Cost estimate excludes multipliers from 2010 (contingency/escalation)

Constructability: Technique Comparison

C&C is the most cost-efficient, but poses the most surface disruption. To minimize surface disruption, either SEM or TBM are effective methods.

Method	Cost – Tunneling Only (2018 US$)	Surface Disruption	Duration of Tunneling Only (Years)	Risk
2010 DEIR	$413± M*	Medium-High**	5	Low- Medium***
C&C	$200 M to $250 M	High	2.5 to 3	Low
SEM	$250 M to $300 M	Low-Medium**	4 to 5	Medium-High
TBM	$300 M to $350 M	Medium-High**	3 to 4	Low- Medium***

*2010 DEIR estimate for the tunneling and station improvements that were re-evaluated was $302±M and duration of construction was estimated to be approximately 60 months. Escalated to 2018 dollars this translates to approximately $413±M.

** Depending on the need for ground improvement and its type, surface disruption would defer.

*** Given low risk of major obstructions.

Next Steps

- Post draft memoranda from analysis
- Gather feedback from MBTA staff and from external stakeholders through Focus40 report feedback process
- Present feedback and recommendation to the FMCB on whether to include in “Next Priorities”

APPENDIX
LAND USE FOLLOW UP

Development of the Volpe Site in Kendall Square

- In 2016, the Massachusetts Institute of Technology (MIT) was selected to redevelop the 14-acre site of the Volpe National Transportation Systems Center
- Current plans estimate 1,400 housing units and 1.7 million square feet of commercial development

Potential Development near Wonderland Station

- **NECCO Factory:** Atlantic Management Company and VMD Companies purchased the former 819,800-sq ft factory site, located less than ½ mile from Wonderland, and plan to redevelop for advanced manufacturing, robotics, bio-technology, and e-commerce.

- **Wonderland Racetrack:** A 34-acre site located directly west of Wonderland station is prime for redevelopment. Such activity could spur redevelopment of other adjacent sites, including the vacant Wonderland Ballroom and the large MBTA surface parking lot.

Logan Airport Projections

- In 2006, Massport projected Logan Airport would serve between 38.3 and 49.5 million passengers by 2020
- In 2017, it served 38.4 million, reaching the low end of the projection
- Massport will likely release projections for 2030 in the Spring of 2019